

A case for reduced skin sensation in high latitude prehistoric Polynesians. G. J. Dias and E. P. Visser, Department of Anatomy and Structural Biology, University of Otago, Dunedin, New Zealand.

This paper assesses an aspect of the hypothesis that Polynesian groups have anatomical adaptations that enabled them to survive in a cool and wet environment. The cranial sensory nerve supply in three skeletal populations, two distinct prehistoric Polynesian groups from New Zealand, the Mori and Maori, and one contemporary Indian group, was investigated to examine the relationship between sensory nerve dimensions, based on the area of cranial nerve foramina, and external environmental temperature. Statistical comparisons between the Polynesians and Indians showed significantly reduced cranial cutaneous sensory nerve foramina size, and therefore diminished facial cutaneous sensory nerve supply in the Polynesians. On this basis we infer that sensory supply to the skin of the infracranial body was also lessened. We propose that reduced skin sensory nerve supply was selected as an adaptation to a cool and wet environment, where it acted as a body energy conserving mechanism by delaying the onset of body warming mechanisms.

Female Dominance in Blue-Eyed Black Lemurs (*Eulemur macaco flavifrons*) at the Duke University Primate Center. L.J. DIGBY, Biological Anthropology & Anatomy, Duke University, Durham, NC 27708 and S.M. KAHLENBERG, Zoology, Ohio Wesleyan University, Delaware, Ohio 43015.

In most anthropoid primate species, males are physically larger than females resulting in male social dominance and priority of access to food. In contrast, lemurs are often sexually monomorphic in body size, and females frequently win aggressive confrontations and/or have priority of access to food. But female dominance is not universal among the lemurs (see papers by Pereira and colleagues) and has been systematically studied in only a handful of species. Information on additional species is needed to analyze the extent and significance of female dominance. Here we present data on the frequency and

outcome of aggressive intersexual interactions in 7 semi-free ranging and captive groups of blue-eyed black lemurs housed at the Duke University Primate Center. Over 250 hours of focal animal samples documenting dominant-subordinate interactions are analyzed. In all 7 groups, females have significantly higher aggression rates than males ( $p < .002$ ), and aggressive interactions with the dominant are unidirectional with the female winning all contests. Older females are dominant over younger in 2 out of the 3 groups with multiple females. In contrast, younger males are subject to less aggression than older males ( $n=2$ ), but this is likely confounded by young males being the son of the dominant female in both groups. Habitat (semi-free ranging vs. captive) and group size (pairs, trios, and a group of 4) seem to play a minimal role in the expression of female dominance. Group composition is likely important, as fathers and daughters were particularly aggressive (up to 2.4 agonistic interactions/hour). In blue-eyed black lemurs, female priority of access to food is gained through direct aggressive interactions rather than male deference. Such aggression, even in the absence of food shortage, is likely to play an important role in evolution of lemur social systems.

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Anthropometric Variation in Native Americans from California. P.C. Dillingham, Department of Anthropology, The University of Tennessee, Knoxville, TN 37996.

Perhaps one of the most influential anthropologists in the history of our relatively young science was Franz Boas. His efforts in the collection of anthropometric data of Native Americans served as a model for additional collection of this type of data by other anthropologists. For example, in the 1920's Edward Winslow Gifford and other anthropologists, such as Alfred Kroeber (a student of Boas), collected anthropometric, pedigree, and blood quantum data from fifty tribes in California (Gifford 1926).

The present study examined the variation and genetic relationships represented in Gifford's anthropometric data. This data consisted of twelve measurements collected from the body, head, and face. However, tribes represented by less than ten individuals were excluded from the analysis. This allowed the inclusion of only fifteen tribes in the analysis. In addition, the sexes were pooled and the data centered on the sex means. Principal component analysis and analysis of variance were used.

The principal components analysis yielded twelve components. The first component is one of stature and arm length, the second of face and nose height, and the third, one of head breadth. The other components tend to be those of single variables and will be discussed in more detail. The analyses of variance performed on

the group mean scores show that there is significant heterogeneity ( $p < .05$ ) in all components except the last two ( $p > .05$ ). In addition, the analyses of variance performed on components one and three demonstrates that they are most responsible for the inter-group variation. A plot of mean group scores from the first and third components based on stature, arm length, and head breadth reveals that those groups that are more closely aligned in the plot also tend to align themselves closely geographically. This may be evidence of the presence of gene flow between the groups and/or common ancestral relationships.

Neandertal mandibular morphology: autapomorphic complex or intraspecific variant? S. DOBSON, Department of Anthropology, University of Michigan, Ann Arbor, MI 48109-1382.

The craniofacial architecture of Neandertals, which is characterized by mid-facial prognathism and a shift of the infraorbital region from the coronal into a more sagittal orientation, may represent an autapomorphic complex resulting from intensive masticatory stress placed on the anterior dentition (Rak 1986). If this hypothesis is correct, then such a complex should manifest itself in mandibular morphology as well. Rak has identified a set of related mandibular features which are said to be autapomorphic to Neandertals.

I investigate the uniqueness of the medial pterygoid tubercle, posterior position of the mandibular notch, inversion of the gonial angle, and central position of the coronoid ridge on the anterior face of the condyle and attempt to refute the hypothesis of autapomorphy by examining whether the features can be found regularly in modern humans. I further examine the association of the features and attempt to refute the hypothesis that they are associated only randomly, because a functional association implies they are found together more commonly than at random. Casts of 10 complete Neandertal mandibles and 200 complete modern human mandibles were diagnosed for the presence or absence of each feature. Observed proportions of each individual feature were compared between samples using binomial tests. Chi-square tests were used to assess the randomness of association of each pairing of features within both samples.

Results indicate that three of the four features occur in significantly higher frequencies in Neandertals, but that none of the features are autapomorphic. Furthermore, no pair of features in either sample deviated significantly from a random association. This evidence does not support a derived functional complex of these four features in Neandertals.

Skeletal health of an elderly sample of Civil War era veterans. H. D. DOCKALL, U.S. Army Central Identification Laboratory, Hawaii, Hickam Air Force Base, HI 96853-5530, and J. E. BAKER, Dept. of Anthropology, Texas A&M University, College Station, TX 77843-4352.

The skeletal remains of 50 Confederate veterans and 6 spouses were excavated during renovations of the Texas State Cemetery in Austin. The sample is unusual in that age of the individuals, known from headstone data and historical documents, ranges from 60-95 years, with an average age at death of 77.3 years. The individuals composing the sample died between the years of 1907-1951, with most burials occurring in 1907 and 1908. Although all material was reburied, skeletal analyses were conducted in a field laboratory. This presentation focuses on the skeletal health of the men and women excavated from this cemetery, utilizing the population's unique historical and demographic character.

Evaluation of stature is often used as an indicator of overall health conditions during the growth process. In the group studied here, stature appears to reflect childhoods that were not adversely affected by a lack of calories and nutrients, or undue stress. Furthermore, the frequencies of porotic hyperostosis and cribra orbitalia, which are suggested to most commonly result from childhood bouts with iron deficiency anemia, are low. Linear enamel hypoplasias were observed in 25% of the individuals. This rate is significantly lower than the rate of 73% of individuals from the Monroe County institutional cemetery (Lanphear 1988) and is also lower than a rural Texas sample dating from the mid to late 1800s (Rose 1992).

Many of the skeletal disorders observed in this elderly sample appear to be a result of the aging process. Degenerative joint disorders were very common, with every individual in the sample exhibiting either axial and/or appendicular changes. Rates of typically age-cumulative dental disorders, such as antemortem tooth loss and caries, were also high. The degrees of dental wear and alveolar resorption also reflect the advanced age of the sample.

The men composing this sample are unusual in that they all fought in the Civil War. Not unexpectedly, evidence for this major life event was observed in the skeletal remains of a few of the men, primarily in the form of apparently battle-related fractures and some gunshot wounds. While historical documents suggested that surgical amputations would be common in this sample, our original expectation was not met, as none of the men evidenced this form of medical intervention.

Oral Health in Southeast Asia. K.M.DOMETT, University of Otago, Dunedin, New Zealand.

This paper presents a study of the dental health of several prehistoric populations from Thailand, SE Asia, and discusses the implications of the transition to an intensive rice-based agriculture.

The presence of dental caries, severe attrition, periapical cavities and antemortem tooth loss (AMTL) has

been assessed in four Thai skeletal populations, comprising 205 adults ( $\geq 15$  years) with teeth and/or alveolar bone. There are two inland sites, Ban Lum Khao (1400 BC, Bronze Age) and Ban Na Di (600-400 BC, Iron Age). The other populations are close to the coast, Khok Phanom Di (2000-1500BC, Neolithic) and Nong Nor (1100-700 BC, Bronze Age). There are no significant differences in the age structures among the populations. These initial results are based on the individual count method.

Ban Na Di and Ban Lum Khao have a very similar dental health profile with a high level of caries (45.5% and 46.5% respectively), a moderate level of severe attrition (24.2 and 34.9%), a low prevalence of periapical cavities (15.2% and 14.0%) and a moderate level of AMTL (30.3% and 30.2%). Their similarity in environment and therefore diet may well account for these near identical results.

Nong Nor shows a pattern consistent with the inland sites but is distinctive in having a significantly high level of severe attrition (56.5%) compared to all populations, indicating a more abrasive diet. Khok Phanom Di has a similar level of caries to all populations but its mean caries rate is significantly higher. These people show a moderate level of severe attrition (29.9%) and high levels of periapical cavities (55.2%) and AMTL (50.7%).

Overall these results do not follow the pattern of dental health seen with the transition to and intensification of agriculture in Europe and America. This contrast may be the result of the SE Asia's rice-based agriculture compared to other carbohydrate staples relied on throughout the world.

In general the earliest population, Khok Phanom Di, shows the highest levels of dental pathologies while Ban Na Di, the most recent population shows the lower prevalences of each pathology. This variation through time will be discussed in the context of an increasing reliance on rice agriculture.

Diet of western lowland gorillas in south-west Central African republic: implications for subspecific variation in gorilla grouping and ranging patterns. D.DORAN<sup>1</sup> and A.MCNEILAGE<sup>2</sup>, <sup>1</sup>Anthropology, SUNY at Stony Brook, NY 11794 and <sup>2</sup>Wildlife Conservation Society, 185<sup>th</sup> St. & Southern Boulevard, Bronx, NY 10460

Gorillas provide a unique opportunity to evaluate proposed models of ecological influences on social organization of African apes because of subspecific variation in foraging strategies. Results are presented here of the diet of western lowland gorillas from a new site, the Mondika Research Center, which is located in the southern (Ndoki) sector of the Parc National de Dzanga-Ndoki, Central African Republic. Analysis of dung samples (based on representative sampling of 1 sample per group per day for two years) indicates that gorillas consume both fruit and non-fruit throughout the year, and that fruit makes up a significant part of the western lowland gorilla's diet at Mondika. Over 50% of the 159 recorded gorilla food items (of 139 species) are fruit. Fruit was present in 99.7% of all dung samples examined (n=324). The average % (by volume) of fruit in dung samples for each season was 40%, but there was considerable variation in the % of fruit per sample per season, ranging from 25%-70%. Fruit

consumption is highest during the minor rainy season (July-September), when dung samples are both fruit dominated (made up of more than 50% fruit) and contain the greatest mean number of fruit species per dung sample (mean = 3.5, range = 2.0 - 5.5). Non-fruit food items (leaves of trees and leaves and stems of terrestrial herbaceous vegetation) are also important to gorillas. The majority of fecal samples were herb dominated; herbs and/or leaf was present in 99.7% of dung samples. The average % of fiber (by volume) in dung sample was 60%, although it varied seasonally ranging from 30% during the major fruiting season to 75% during the major dry season. The general pattern of gorilla diet in this study is similar to that of western lowland gorillas studied elsewhere, and distinct from that of mountain gorillas as a result of the greater incorporation of fruit in the diet. Evidence for subspecific variation in gorilla social organization is discussed in light of subspecific variation in foraging strategy.

Evolutionary implications of hominoid upper-limb proportions. M.S. DRAPEAU, University of Missouri, Columbia, MO 65211

Allometric scaling patterns within the forelimb differ among extant hominoid taxa. Understanding the evolutionary polarity of forelimb proportions is necessary to accurately reconstruct the ancestral condition from which australopithecines evolved.

Research suggests that humerus length scales roughly isometrically to body weight across hominoid taxa. Forearms (here measured as ulna length) are long relative to the humerus in *Hylobates* and *Pongo*, and only slightly so in *Pan*. *Gorilla* and humans are similar, exhibiting the shortest ulnae. The capitate generally scales isometrically with body weight in most taxa, suggesting that the wrist may be under stricter functional constraints than other upper-limb segments. The scaling relation between metacarpals (MC3 in this study) and the ulna is surprisingly similar across hominoids and in many other anthropoids. *Pan*, however, has uniquely long metacarpals.

These results suggest that changes in limb segment length are not determined by systemic mechanisms affecting the whole limb. Instead, they suggest that changes take place in the growth plates (also seen by Reno et al. 1998), a mechanism that apparently allows segment specific responses to mechanical and functional demands imposed by activity patterns.

The associated forelimb remains of the newly discovered A.L. 438-1 specimen (Kimbel et al. 1994) indicate that *Australopithecus afarensis* had forearm to metacarpal proportions similar to most hominoids. The human-like proportions of A.L. 438-1 appear to be primitive in contrast with the derived condition exhibited by *Pan*. Thus, there is no necessary evidence of reduction of metacarpal relative to ulna lengths in early hominid evolution. The polarity of the australopithecines brachial index, which is intermediate between that of *Pan* and humans, is more difficult to interpret given the variation among extant African hominoids.

These results underscore that australopithecines did not necessarily evolve from an ancestor with *Pan*-like morphology. Caution is needed when interpreting direction of morphological change in early hominid forelimb evolution.

Crenulated molar enamel in Primates: a functional model. E. R. DUMONT, Northeastern Ohio Universities, College of Medicine, Rootstown OH 44240, USA.

Enamel crenulation is defined as wrinkling on tooth surfaces that is independent of crest, cusps or cristid formation. Despite the wide distribution of crenulated enamel among both extant and fossil primates, few functional interpretations of crenulation have been offered. Among these are suggestions that crenulation on molar teeth aids both in grinding and in shearing during mastication. This study proposes a model of molar crenulation that accounts for these contrasting roles.

On shearing surfaces, crenulations are predicted to be relatively long, narrow, and arrayed parallel to the direction of tooth movement. As corresponding upper and lower molar surfaces move past one another, these crenulations would impose a series of alternating three-point bending moments on the intervening food item. According to the model, this pattern of crenulation should typify folivores, where additional bending forces contribute to breaking down tough leaves. Molar crushing surfaces, on the other hand, should display crenulations that are more rounded and randomly distributed. These crenulations would serve two functions: 1.) to concentrate crushing forces, and 2.) to increase friction in order to keep food from slipping off the grinding surface. The model predicts that this form of crenulation will be common among both seed predators and frugivores, where it is only a slight modification of the well-documented 'mortar and pestle' molar design.

Predictions derived from this model of crenulation function are assessed in a brief survey of crenulation on molar teeth of folivorous and frugivorous primates.

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Mortuary practice in ritual contexts among the Postclassic Maya, El Petén, Guatemala. W.N. DUNCAN, Department of Anthropology, Southern Illinois University, Carbondale, IL 62901.

Ethnohistorical and architectural lines of evidence suggest that three Maya social groups, the Itzá, K'owoj, and Yalain, lived contemporaneously around Lake Petén Itzá in northern Guatemala during the Postclassic period. Recent excavations at Ixlú and Zacpetén have recovered human remains suggesting that two of these groups, the Itzá and K'owoj respectively, may have maintained distinctive mortuary practices in some ritual contexts.

At Ixlú, human skeletal remains were

interred in linear arrangements. Three pairs of crania with articulated vertebrae were found in an east-west line. Perpendicular to this were four semi-articulated postcrania, which exhibit numerous cut marks at joints, suggesting perimortem dismemberment. At Zacpetén, though, preliminary excavations have revealed an ossuary consisting of semi-articulated skeletal remains that appear to have experienced perimortem dismemberment. The bones from these sites were examined with a 10X magnification lens under oblique light to identify cut marks. This paper presents the preliminary interpretations of these mortuary practices and explores the possibility of using osteological studies in conjunction with other lines of evidence to distinguish Postclassic Maya social groups in the archaeological record.

Infant Feeding Practices in Roman Egypt: Evidence From the Dakhleh Oasis, Egypt

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The weaning of infants onto cow's milk appears to be a common practice in ancient Egypt. Iconographic and archaeological evidence shows infants suckling on cow's teats, and artifacts identified as bottles have been found in several archaeological sites. However, it is unknown what affect the numerous political and economical changes throughout Egypt's history had on this practice. Carbon and nitrogen stable isotope analysis of infant/juvenile remains from a Romano-Christian burial site (300-400 AD), located east of the ancient village of Kellis, in the Dakhleh Oasis, Egypt, not only indicate the timing of the weaning process, but also suggests what food infants were weaned onto.

A sample of infants/juveniles (N=51) from this site has been analyzed for their  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  isotope values. Carbon isotope values indicate that the majority of infants were breast fed up to the age of one year. At this point infant  $\delta^{13}\text{C}$  values become increasingly enriched until two years of age. This enrichment signals the introduction of other foods into the diet, possibly cow and/or goat milk. After the age of three the carbon isotope values level out to values reflective of the adults in the population, suggesting a switch to the same foods consumed by the adults.

Nitrogen isotope values display a similar pattern, with infants under the age of one being very enriched in  $\delta^{15}\text{N}$  ( $\bar{x} = +20.71\text{‰}$ , compared to  $\bar{x} = +17.9\text{‰}$  for adults), reflecting the trophic level effect from consuming maternal breast milk. After the age of one the  $\delta^{15}\text{N}$  values of the infants begin to decrease, indicating a change in diet. After the age of three the infant/juvenile  $\delta^{15}\text{N}$  values are similar to those of the adult population.



The human skeletal material from the Swedish man-of-war *Kronan* - a cultural-historical interpretation with question-marks. E.M.DURING, Archaeosteological Research Laboratory, Stockholm Univ., Sweden.

The material emanates from the Swedish 17th century man-of-war, *Kronan* which capsized, exploded and sank on the 1st of June 1676 before the beginning of an action between the Swedish and the allied Danish-Dutch fleet.

The osteological analysis up to now shows that the material (about 400 kg) represents 150-200 of the approximately 600 individuals who went to the bottom with the ship. During the investigation a great number of unhealed marks of cuts and blows were observed on cranial as well as post-cranial skeletal remains. The injuries, similar to injuries made by bladed weapons, are highly puzzling since, according to contemporary sources as well as today's historians, *Kronan* had *not*, since she began her voyage on the 19th of May, been involved in a man-to-man combat.

To get a better statistical view of the injuries and be able to describe the number of marks, their exact position on different skeletal elements, from which direction they were aimed and, if possible, with which weapon/instrument they were inflicted, a detailed analysis has started in collaboration with the forensic pathologist Jan Lindberg, MD at the Government institute of forensic medicine, Karolinska institutet and experts in arms at the Army museum, Stockholm. Preliminary results from the analysis are presented here.

Up to now, taking into consideration the more complete parts of all long bones (ca 1100 specimens), about 10 % show similar injuries. The result indicates that the most common skeletal elements exposed to traumatic actions are the femora and the tibiae. On the whole, the diaphyses seem to be the most common place where to find the injuries. However, articular surfaces have also been damaged. The bones seem to have been hit from many different directions. Without doubt the presence of these injuries is a main problem to be solved in connection with a cultural-historical interpretation of what happened on board before *Kronan* met her tragic fate.

The research project "The Swedish Warship *Kronan* - An osteological and microanalytical investigation of the human skeletal material" is supported by means from the Swedish Council of Research in the Humanistic and Social Sciences and Kalmar Läns Museum.

The child victims of the plague epidemics of 1590, 1721 and 1722 in southeastern France. O. DUTOUR, M. SIGNOLI, S.BELLO and Gy. PALFI, Dpt of Biological Anthropology, UMR 6578 CNRS-University of La Méditerranée, Faculty of Medicine, F-13885 Marseille Cedex 5.

The plague was a major epidemic in the past. It had a dramatic impact on demography and evolution of human populations. However, characteristics of its impact on the population structure are poorly known (Hollingworth 1971). According to Biraben (1975), the plague mortality decreases with the age and consequently the children are the main victims of plague epidemics. In order to precise the effect of plague epidemics on population structure, we studied the distribution of age at death both on paleodemographic and historic material. Skeletal data were constituted by 351 skeletons coming from

3 plague mass graves dated from 1590 and 1720-1722 epidemics in Provence, representing 3 distinct phases of epidemic process (respectively controlled, acme, relapse). Historical data were composed of 4749 deaths by plague collected from 1720-1722 parish registers. Results obtained on skeletal material showed a percentage age distribution varying from 16 to 36% for the 0-9 yrs (C1) and from 10 to 13% for the 10-19 yrs (C2) age cohorts, showing that the most represented age group is the youngest (C1). The percentage of immature individuals in these series varies from 28 to 46%. We explained this variation as differences in child-juvenile mortality in function of epidemic phases (in case of relapse, the lowest percentage is observed in C1). Results obtained from historical records evidenced the same age distribution pattern of young victims (C1: 23%, C2: 17%) and confirmed the low percentage in C1 in relapse phase. Mortality rates by plague compared with natural mortality (NM) varied in function of the age categories (twice for C1, 20 times for C2, versus 8 times for adults).

High rate observed for C2 is explained by the low natural mortality in this age group. In normal conditions, 60% of deaths concerned the youngest part of these populations (under 20). Our results showed that (i) plague epidemics in the past have had a significant quantitative effect on child mortality (150% increase) but it stays inferior to the increasing adult mortality (+700%) (ii) observed child mortality by plague depended on the age (victims were mainly the juveniles C2) and on the phase of epidemic (iii) the plague mortality was not a simple increase in mortality : surprisingly it spared the population structure and therefore preserved the reproductive ability of the populations allowing their demographic recovering.

Evolutionary morphology: dynamics of adaptation in New World populations support continuity in Old World successions. R. B. ECKHARDT, The Pennsylvania State University, University Park, PA 16802.

It has been argued that neanderthals cannot be ancestral to anatomically modern human populations in Europe because such a hypothetical succession would require impossibly high evolutionary rates in multiple morphological characters. A general test of this idea is provided in any situation where populations are genetically continuous and the time and character state differences between earlier human groups and their lineal descendants can be measured or estimated within relatively narrow limits of error.

One clear example of pronounced morphological change against a background of evolutionary continuity is provided by New World populations that extended their adaptive range from sea level to high altitude (above 3000 m) in South America. Among the morphological adaptations that accrued over the last ten millennia were increases in transverse thoracic breadth of 3.5%, anterior-posterior thoracic diameter of 13.1% and sternal length of 14.4%. In the extant high altitude reference population these dimensions had low to moderate heritabilities of 0.15, 0.28 and 0.34, respectively. For the same three dimensions, the indicated rates of morphological change from sea level to highland populations are 3.45 darwins,

12.33 darwins and 13.45 darwins. These estimated evolutionary rates are more than an order of magnitude higher than the rates of change in 14 linear dimensions between neanderthals and early Upper Paleolithic populations calculated by Frayer (1997). If morphological characters and rates of morphometric change are to be used as criteria to assess relationship among populations, then there must be a common standard used in studying the biology of past and present populations.

Physical properties of *Gorilla g. beringei* foods and implications for masticatory form. A. A. Elgart, Ecology and Systematics, Cornell University, Ithaca, NY 14853.

Most masticatory biomechanical studies form predictions about morphology using broad dietary categories, which fail under scrutiny. This investigation quantified material properties of the diets of two populations of mountain gorilla (*Gorilla g. beringei*) in Uganda, and compared the morphology of the masticatory apparatus of these two populations. The diet of the mountain gorilla in the Virunga Volcanoes has been viewed as tougher than the diet of other gorillas, including that of the other *G. g. beringei* population in this study. Higher toughness values necessitate an increased number of power strokes to process the food. If the fracture toughness of the food items does not differ significantly between the two populations, then any masticatory form differences found between the two would not be attributable to diet.

This study focused on two Ugandan gorilla groups, the Kyagurilo group in Bwindi 'Impenetrable' National Park (BINP), and the Nyakagezi group in Mgahinga National Park (MNP), in the Virunga Volcanoes. The most commonly eaten gorilla food plants, identified through published and unpublished records, were collected and tested in these two parks. The toughest portions of 57 species of bark, pith, leaves, fruit and fungi were sheared with a test piece at a constant rate on a test stand. The test piece was connected to a Shimpo force gauge. The work of fracture ( $\text{N/mm}^2$ ) was calculated from the area beneath the force-displacement curves generated. Student's t-tests and ANOVA were used to compare the work of fracture, by plant class, and by frequency, between BINP and MNP.

Thirty-four dimensions of the cranium and teeth of female *Gorilla g. beringei* from BINP ( $n=5$ ) and the Virungas ( $n=8$ ) were measured. These included overall size measurements, measurements which vary among gorilla populations, and measurements which vary with masticatory biomechanics, such as height of ramus, mandibular corpus height and width and symphyseal height and width.

Preliminary results indicate that the leaves eaten by the Nyakagezi group were significantly tougher (mean:  $23.5 \text{ N/mm}^2$ ,  $p=0.003$ ) than those eaten by the Kyagurilo group (mean:  $9.8 \text{ N/mm}^2$ ), but leaves had the lowest toughness of any food class. No other differences were significant. The bark in BINP, which constitutes 28% of the diet had a mean fracture toughness of  $133.4 \text{ N/mm}^2$ . Five mandibular dimensions were significantly different ( $p<0.05$ ) between the two populations. These results are discussed.

Cranial capacity trends in African Plio-Pleistocene cercopithecoids. S. ELTON, Department of Biological Anthropology, University of Cambridge, UK

Encephalization has been linked with ecological and social adaptations across primate taxa. However, there has been very little work on evolutionary trends in encephalization within Plio-Pleistocene cercopithecoid lineages, in contrast with the extensive documentation of changes in endocranial volume in Plio-Pleistocene hominids.

Measuring endocranial volume in fossil cercopithecoids is difficult due to incomplete skulls or presence of matrix, and published regression equations for predicting cranial capacity from external skull dimensions give inaccurate estimates. A method for predicting cranial capacity from external dimensions for extant Old World monkeys has been developed and used to estimate cranial capacity in Plio-Pleistocene fossil cercopithecoids.

The extant sample comprised 311 crania from six cercopithecoid genera. The fossil sample comprised crania from southern and east African Plio-Pleistocene monkey genera, including *Parapapio*, *Cercopithecoides* and *Theropithecus*. 15 cranial measurements were made on the extant and fossil sample with the addition of cranial capacity in the extant material. Regression equations derived from the extant data were applied to fossil cercopithecoid crania of unknown cranial capacity. The resulting predictions, along with directly-measured fossil cranial capacities, showed that, relative to estimated body mass, cranial capacity in *Parapapio* and *Cercopithecoides* did not change over the course of the Plio-Pleistocene. In *Theropithecus*, cranial capacity decreased relative to body mass over time. This is likely to be because brain size does not increase proportionally during periods of rapid body size increase. These trends contrast markedly with the encephalization seen in hominids during the Plio-Pleistocene.

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Symmorphosis and the respiratory capacity of the upper airway. THOMAS L. ESTENSON, University of New Mexico, Albuquerque, NM 87131

The concept of symmorphosis as developed by Weibel and Taylor posits that biological structures within a functional system are designed such that the performance capacity of each element in the system will correlate with the maximum performance requirements of the overall system. This insight acknowledges that the peak capacity of a multi-stepped system will be limited by the least productive step. Weibel and Taylor also state that the requirements of the overall system impose constraints on the design of the individual components. The capacity of individual elements should not exceed the requirements of

the system. Overall, symmorphosis is an argument for optimality in biological systems. The initial work of Weibel, Taylor and associates investigated the capacity of the mammalian respiratory system. They quantified and compared function and morphology of respiratory elements downstream from the lung among animals of different sizes and activity patterns. Overall, they found support for their hypothesis.

This study examines structural elements of the respiratory system upstream from the lungs--the cross-sectional area and volume of the nasopharynx. There is a string of correlations from body size to metabolic rate to oxygen requirements to lung volume. On the assumption that the "tube" supplying oxygen to the lung (the upper airway) should correlate to oxygen requirements, this study investigated the correlation of body size and the nasopharynx. Rather than attempting to establish size by measuring soft tissue, the nasopharynx was delimited by bony and muscular attachment areas on the cranial bases of 100 individuals from the Terry collection for whom heights and weights were recorded. Volume and cross sectional areas were taken and statistical comparisons were made for the entire group and various subgroups. Correlations were strongest for males and younger individuals and *r* values ranged from .18 to .89. Symmorphosis for these components of the system was supported for a core percentage of each subgroup but 10-20% were "outliers". Possible reasons for these non-correlations are presented.

Ancient DNA diagnosis of bone pathology in infancy and early childhood. M.FAERMAN, Hadassah School of Dental Medicine, Hebrew University, POB 12272, Jerusalem 91120, Israel.

In past populations infectious and genetic diseases as well as malnutrition resulted in high mortality of infants and children. Investigations of infant remains based on morphological, roentgenological and histological findings allow presumptive diagnoses of pathological conditions. Similar bone pathology caused by various factors may impede a differential diagnosis. This, in turn, may misrepresent spectrum and real frequencies of diseases in the past.

Recent achievements in ancient DNA research offer the unique opportunity to clarify the precise cause of a certain bone pathology. Direct evidence can be obtained by studying DNA recovered from archaeological specimens. The analysis comprises amplification and direct sequencing of human and/or microbacterial DNA fragments of interest and subsequent comparison with known sequences in healthy individuals and patients.

This approach has been applied to the differential diagnosis of anemias in archaeological remains showing porotic hyperostosis. This pathological condition may be a result of genetic ( $\beta$ -thalassemia, sickle-cell anemia) or acquired anemias due to nutritional conditions

(iron-deficiency anemia, rickets, scurvy) and chronic infections. We have analyzed  $\beta$ -globin sequences retrieved from a number of skeletal remains with pathological lesions suggestive of anemia: 8-year-old, Achziv, Israel, 16<sup>th</sup> c. AD; 6-month-old, Ikiztepe, Turkey, Early Bronze Age; 10-year-old, La Florida, USA, 15<sup>th</sup> c. AD and 9-year-old, Jelšovce, Slovenia, Early Bronze Age. Porotic hyperostosis in the child from Achziv was found to be caused by homozygosity for a known frameshift mutation in the  $\beta$ -globin gene, leading to  $\beta$ -thalassemia major. So far, no mutations have been observed in a 178-bp  $\beta$ -globin sequence recovered from the La Florida specimen and a 166-bp sequence from the Jelšovce specimen.

The reliability of ancient DNA analysis in tracing mutations in the  $\beta$ -globin gene of DNA isolated from archaeological specimens are discussed.

Quantitative Analysis of Primate Trabecular Bone Architecture: Comparison of High Resolution X-ray Computed Tomography and Histologic Sections. R.J. FAJARDO, Doctoral Program in Anthropological Sciences, SUNY at Stony Brook, Stony Brook, NY 11794, T.M. RYAN, and J. KAPPELMAN Department of Anthropology, The University of Texas at Austin, Austin, TX, 78712-1086.

High Resolution X-ray Computed Tomography (HRXCT) is a new imaging approach with a resolution in the tens of microns. Such resolution is necessary to accurately quantify very small structures, including parameters of trabecular bone architecture. Of critical importance in any study that utilizes CT technology is the need to assess its accuracy by comparing measurements taken from the scan images with measurements taken from the actual specimens. To determine the accuracy of HRXCT, parameters of trabecular architecture in a sample of baboon femora and humeri were measured both on the images produced by a new scanner at the University of Texas at Austin (see <http://www.ctlab.geo.utexas.edu/>) and on thin sections of the bones. The histomorphometric measurements include the bone volume fraction, trabecular thickness, trabecular number, and trabecular orientation.

Two samples each were taken from the proximal femur and proximal humerus of 7 individuals using a diamond blade saw. The samples were ground on diamond-laced sanders to produce smooth, parallel surfaces. All samples were scanned beginning one millimeter from the cut plane with a 40 micron slice thickness. After scanning, each specimen was infiltrated and embedded with an epoxy resin and sectioned using a diamond blade microtome. The results from HRXCT images and histologic sections were analyzed to determine a percentage error between the two approaches and the strength of their correlation. Preliminary results indicate that the HRXCT accurately resolves the trabecular bone.

HRXCT technology provides a non-destructive method for the quantitative analysis of internal bone architecture in recent specimens. This technology will prove to be extremely useful to physical anthropologists because the high resolution of the HRXCT scanner facilitates the noninvasive and nondestructive analysis of very small specimens and structures for the first time.

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Brain evolution in gracile australopithecines: Was *A. africanus* the mother of us all? D. FALK, Department of Anthropology, SUNY at Albany, NY 12222.

The sample size of australopithecine endocasts has increased in recent years due to the discovery of new specimens including gracile australopithecine Stw 505 and robust australopithecines KNM-WT 17000, KNM-WT 17400, and KNM-ER 23000. As a result, models now exist for previously unknown portions of the cerebral cortex in robust australopithecines, e.g. the orbital surface of the frontal lobes, making possible a comparison and reappraisal of cortical morphology in gracile and robust australopithecines. Comparative analyses were carried out on the above endocasts and those from Sts 60, Sts 71, Sts 19, the No. 2 specimen from Sterkfontein, Taung, Sts 5, SK 1585, KNM-ER 732, KNM-ER 407, and OH 5. Compared to robust australopithecines, gracile australopithecines have expanded frontal lobes in the general region of the frontal poles, that appear to correspond to Brodmann's area 10 in chimpanzees and humans. In humans, this area is involved in abstract thinking, planning of future actions, and undertaking initiatives. Compared to robust australopithecines, the temporal poles of gracile australopithecines project further rostrally relative to the sella, and are expanded in their rostral lateral extent giving them a more laterally pointed shape. In this regard, when compared to apes, the temporal poles of gracile australopithecines are more derived and humanlike than those of robust australopithecines. The temporal poles of both chimpanzees and humans connect with the orbitofrontal cortex, and the rostral lateral region of the temporal poles of humans are activated during the recognition and naming of familiar human faces. Reorganization of the orbitofrontal cortex and temporal poles towards the derived human condition appears to have been underway during early hominid brain evolution in gracile but not robust australopithecines. This finding is consistent with the recently revived suggestion that *A. africanus* may have given rise to early *Homo*.

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Multivariate Modeling of childhood diet and health in Prehistoric Peru. J. Farnum, Department of Anthropology, University of Missouri-Columbia, MO 65211.

Infant and childhood health are influenced by a variety of physical, biological, and social factors. These include: diet type, food quantity, disease load, seasonality of food availability, as well as family/social influences. Trace element, linear enamel hypoplasia (LEH), and stable isotope data have been used in previous studies of community health. Present analyses are based on trace element data and non-specific indicators of stress (NSIS), as well as, skeletal measurements of children from the Preceramic sites of Paloma and Asia from Peru.

Decreasing levels of zinc and iron in the post-weaning period (3.5-5 yr) are associated with increasing susceptibility/expression of NSIS especially porotic hyperostosis and linear enamel hypoplasias. A relative maximum of LEH (and relative minimum in zinc concentration) indicates the probable introduction of supplementary foods around age 1 with a continuation until complete weaning near age 3-3.5. The significant decrease in bone iron and zinc ( $p = 0.03$ ) after weaning may be due to a prolonged reliance on breast milk. Manova and multidimensional scaling are further used for modeling broader spatial patterns in skeletal and dietary reconstructions, as well as, testing for interactions between NSIS, skeletal measurements, trace elements, and demographic variables.

Is there adaptive value to reproductive termination in Japanese macaques? A test of the grandmother hypothesis. L.M. FEDIGAN and M.S.M. PAVELKA, Anthropology, Univ. of Alberta, Canada T6G 2H4 & Anthropology Univ. of Calgary, Alberta, Canada T2N 1N4.

The pattern of early reproductive senescence in women (menopause) has been explained as directly adaptive (the grandmother hypothesis) and as indirectly adaptive (a byproduct of some other adaptive trait, such as increased longevity). This debate has been extended to explain reproductive senescence in nonhuman primates as well. Here we test the grandmother hypothesis in a nonhuman primate species (*Macaca fuscata*) in which some females experience a post-reproductive period and which exhibits matrilineal social structure and extensive care of infants by maternal kin. We compare first and second generation offspring survival rates for two categories of Arashiyama West Japanese macaque females: those who terminate reproduction prior to death ( $N=20$ ), and those who continue to reproduce until death ( $N=50$ ). We distinguish reproductive termination from a female's final interbirth interval, using a criterion developed by Caro et al. (1995), and we examine offspring survivorship using life table survival analyses. The results indicate that reproductively terminated females lived significantly longer (24.6 versus 17.4 years) and had higher fecundity (9.7 versus 7.7 infants) than did females who continued to reproduce until death. However there were no significant differences in the survivorship rates of first or second generation descendants. We conclude that terminating females in this population have greater fecundity because they live significantly longer and experience more years in which to give birth, but they do not significantly increase the survivorship of their existing young. Thus the grandmother hypothesis is not supported by our findings.

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Stressing the system to learn more about the role of genetic variation in human physiology. FERRELL, R.E., Department of Human Genetics, University of Pittsburgh, PA 15261

Historically, attempts to define the role of polymorphic variation at biologically plausible candidate gene loci in influencing quantitative risk factors for common disease have been conducted using cross-sectional association studies. Examples are the numerous studies of the association between apolipoprotein gene variation and fasting lipid/lipoprotein levels. These studies do not address the issue of the role of genetic variation in determining an individual's response to environmental or biological stressors; maintaining metabolic homeostasis. Using data from a defined, moderate intensity aerobic exercise intervention designed to improve individual cardiovascular disease risk profiles, we will illustrate the influence of apolipoprotein E genotype on the HDL response to exercise and the influence of angiotensin converting enzyme genotype on blood pressure related variables.

Pregnancy represents a biologically defined state which imposes significant metabolic stress in females. We show that lipoprotein lipase genotype at several functionally important polymorphic sites influences the risk of developing pregnancy associated dyslipidemia and hypertension. These examples will illustrate how the study of genes in the context of an environmental or a biological challenge may reveal genotypic effects not detected in cross-sectional studies.

Comparison of subsistence strategies of Neandertal and modern human populations using faunal analysis. J.L. FISH, Department of Anthropology, Arizona State University, Tempe, AZ 85287.

A key issue in the modern human origins debate is the cultural distinctiveness of Neandertal behavior. This project focuses on two areas where both Neandertal and modern human habitation sites have been found in close proximity; cave sites in the Levant and habitation areas in France. Current evidence suggests that Neandertals and modern humans existed contemporaneously in the Levant. At sites in France, Neandertals disappear at the same time that modern human populations are rapidly expanding.

The primary method for assessing potential behavioral differences between these two groups has been to analyze the lithic technology at different sites. Few attempts have been made at analyzing behavioral patterns based on faunal analysis. The animal species present at these sites are similar, so this study attempts to elicit differences in

subsistence between these two hominin groups as illustrated by frequencies of species representation. The subsistence base is determined using macromammal faunal data. NISPs and MNIs are used to determine the percent representation of each species present.

For example, at sites occupied by Neandertals (Kebara and Amud), *Gazella gazella* has the highest frequency of any accumulated mammal. Various behaviors of the mountain gazelle, including its lack of migratory behavior, distinguish it from *Alcelaphus buselaphus* and *Bos* sp. which are most common in sites occupied by modern humans (Qafzeh and Skhul). Furthermore, Neandertal faunal accumulations reflect an intensive focus on one species. In contrast, modern human accumulations exhibit a more diverse distribution of fauna.

These data are consistent with Lieberman and Shea's (1994) proposal (based on cementum analysis of mountain gazelle teeth) that Neandertals were year-round occupants of sites in the Levant, contrasting with seasonal occupation by modern humans. This analysis supports the hypothesis that Neandertals are characterized by different cultural adaptations than those of modern human populations.

Biocultural correlates of health among the Cofán of Ecuador. L.J. FITTON Department of Anthropology, The Ohio State University, Columbus, OH 43210.

Economic development of tropical rainforests affects the health of indigenous populations. Environmental and cultural change have depleted natural resources, undermined traditional subsistence, increased population densities, and disrupted social systems thereby modifying health and disease patterns of native populations.

During August, 1996 physiological measures (anthropometrics, blood pressure, blood glucose, cholesterol and hemoglobin, fecal parasite loads, eosinophil counts and dental exams) and health surveys were completed in two Cofán villages of Northeastern Ecuador, Dureno and Zabalo, who are encountering differential acculturation. Dureno is experiencing encroachment by oil companies, logging, and cattle ranching. Zabalo, located 60 miles downriver from Dureno in a protected area, the Cuyabeno Reserve, is more buffered from some of the stressors experienced in Dureno.

One hundred and six adults participated in this study (Dureno=60, Zabalo=46). Estimated age averaged 34 years in Dureno (range: 13-76) and 28 years in Zabalo (range: 13-63). Systolic and diastolic blood pressure were higher in Dureno ( $\bar{x}$ =119/72) than in Zabalo ( $\bar{x}$ =113/67) ( $p$ =.029, .004). Skinfold measures (suprailliac, subscapular, and triceps) were larger in Dureno ( $p$ =.062, .061, .063). Roundworm infections (*Ascaris lumbricoides*) were more frequent in Dureno ( $p$ =.039) however, eosinophil counts and hemoglobin levels were

more similar ( $p=.137, .152$ ). Missing teeth occurred more frequently in Dureno ( $p=.004$ ) however, decayed teeth were more frequent in Zabalo ( $p=.120$ ). Mean blood glucose and cholesterol levels were similar in both groups.

It appears that stressors induced by environmental and cultural change may be precipitating changes in health status among this indigenous population.

Deciduous crown formation times determined by histological microstructural analysis. C FITZGERALD<sup>1</sup>, SR SAUNDERS<sup>1</sup>, R MACCHIARELLI<sup>2</sup>, and L BONDOLI<sup>2</sup>, <sup>1</sup>Dept of Anthropology, McMaster University, Canada, and <sup>2</sup>National Prehistoric Ethnographic "L. Pigorini" Museum, Rome, Italy.

Despite its importance in anthropology and elsewhere, accurate information on deciduous tooth development is scarce. Deciduous dental formation standards have evolved in large measure from one early study based on a small sample of unhealthy children. This has been supplemented by a few later studies, most radiographically based, which have been both semi-longitudinal and cross-sectional. Almost all of these have used modern well-nourished populations of European extraction. In addition to the problems associated with estimating development stages from radiographs, studies also suffer from methodological inconsistencies that make comparison and interpretation difficult.

This study assesses crown development endogenously from a large sample of deciduous tooth sections from children excavated from the Imperial Roman necropolis of Isola Sacra, 2<sup>nd</sup>-3<sup>rd</sup> century A.D. Crown formation times were calculated from the microstructural growth markers of enamel, cross striations and striae of Retzius. Methodology was standardised to make large-scale assessment feasible, and data were collected and interpreted using computer based digital image hardware and analysis software. Images were mainly derived from a polarising LM, but have been supplemented with those acquired using laser confocal microscopy.

Early results indicate that crown development times for this population fall just outside of the top end of ranges in Moorrees et al. (1963).

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The foraging adaptations of the *Cercocebus-Mandrillus* clade. J.G. FLEAGLE, Department of Anatomical Sciences, SUNY at Stony Brook, Stony Brook, NY 11794 and W.S. MCGRAW, Department of Anatomy, NYCOM, Old Westbury, NY 11568.

The phylogenetic relationships among Papionin monkeys have been a source of continued debate.

Molecular studies suggest that mandrills and drills (*Mandrillus*) are more closely related to the torquatus (*atys*)-*galeritus* group of mangabeys placed in the genus *Cercocebus*, while baboons (*Papio*) are most closely related to the *albigena-aterrimus* mangabeys, now commonly placed in the genus *Lophocebus*. However, this evidence has not been accepted by most primate systematists because morphologists have been unable to identify any anatomical features linking either mangabey group with baboons or mandrills.

Recently, we identified numerous features of scapula, humerus, radius, ulna, pelvis, femur, tibia and dentition which unite *Cercocebus* and *Mandrillus* to the exclusion of *Lophocebus* and *Papio* (Fleagle and McGraw 1998). Moreover, newly emerging data on free-ranging *Cercocebus atys* and continuing studies on *Mandrillus* suggest that the morphological features uniting these genera are indicative of a common foraging scheme.

Based on recent data from the Ivory Coast on the sooty mangabey (McGraw 1998, Bergmueller 1998) and reports from the literature on *Mandrillus*, we conclude that monkeys of the *Cercocebus-Mandrillus* clade can be characterized as predominantly ground-dwelling cercopithecids that rely extensively on hard fruits and seeds. These monkeys are aggressive manual foragers that spend large portions of the day pawing through leaf litter on the forest floor in search of fallen food items, many of which cannot be eaten by other sympatric monkeys. The ability to subsist on widely dispersed foods (e.g. *Anthonata*, *Sacoglottis*, *Dialium*) which is reflected in the monkeys flexible grouping and ranging patterns, very large home ranges, and skeleto-dental anatomy, is a key adaptation uniquely shared by these papionin members.

Fluctuating asymmetry, stress, and health among children in a Caribbean village. M.V. FLINN, Department of Anthropology, University of Missouri, Columbia, MO 65211, D. V. LEONE, Department of Anthropology, University of Missouri, and B.G. ENGLAND, Department of Pathology, University of Michigan Hospitals, Ann Arbor, MI 48109

We investigate fluctuating asymmetry (FA), hormonal stress response, immune function, and health among children in a natural (non-clinical) environment. The purpose is to identify associations among childhood growth, stress, immunity, health, and caretaking environment.

Bilateral anthropometric measures are used to estimate relative developmental instability in the growth patterns of 137 children residing in a rural village on the island of Dominica. Analyses of data indicate that FA is associated with illness, growth disruptions, and unstable family environments during early childhood, but not with average levels of salivary cortisol or secretory immunoglobulin-A. Longitudinal analyses suggest that FA is stable over a two-year period. Individual cases suggest that FA is associated with illness that perturbs normal

growth spurts, and that subsequent "catch-up" growth does not resolve the asymmetry.

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**Analysis of polymorphic nuclear markers in DNA extracted from archived Native American hair shafts.** L.E. FLOURNOY, Dept. of Anthropology, University of Tennessee, Knoxville, TN 37996.

Analysis of ancient DNA has proven to be difficult due to effects of low yields, fragmented DNA and the presence of inhibitors. Inhibitors of the PCR process can develop in aged tissues and may also infiltrate specimens from surrounding substrates. The few reports of successful examination of ancient nuclear DNA sequences have used unusually well preserved specimens as a source of DNA. The study of mitochondrial DNA has been more successful due to the large number of mtDNA molecules per cell.

I report the first successful analysis of nuclear polymorphic markers in DNA extracted from archived Native American hair shafts. The DNA extraction technique and PCR methods used in this study are modifications of several published methods. DNA extracted from these 100 year-old hair specimens was analyzed for the genotype at the PAI-1 locus, a two allele polymorphic marker reported to be associated with increased risk for cardiovascular disease in patients with non-insulin dependent diabetes mellitus. The variation at this site occurs in a run of either 4 or 5 Gs and was amplified in a section approximately 140 bases long. Among the 18 individuals of Chippewa and Choctaw descent tested, 1 was found to be homozygous for the 4G form of the polymorphism, 7 were homozygous for the 5G form and 1 sample was a heterozygote. The remaining samples did not produce interpretable results with the current methods. These results indicate that nuclear loci can now be used in population studies when hair samples are available.

This research was supported by a grant from PMERF, University of Tennessee Medical Center.

Socioeconomic conditions as reflected by yearly fluctuations in mean height or weight: Time series analysis of cross-sectional data from Taiwan, 1969 to 1990. B. FLOYD, Department of Anthropology, University of Oregon, Eugene, OR 97403-1218.

Cross-sectional heights and weights collected by Taiwan's Ministry of Education in Taiwan since 1964, and reported

separately for Taipei and rural townships from 1969 through 1990, are used to test the hypothesis that age specific yearly fluctuations in mean height and weight are a sensitive indicator of short-term socioeconomically related environmental change. The intensity of the response is hypothesized to be a function of socioeconomic circumstances and the sex and age related capacity to respond. Results are evaluated using time series derived correlations of yearly change in region and sex specific age group height or weight means, and through graphic comparisons of change over time. This study takes advantage of well documented economic trends in Taiwan, recent growth being interrupted only twice by recessions experienced in 1974 through 1975 and in 1981 through 1982 (Hou and Wu, 1986). Evidence will be presented that confounding from sampling error and small differences in age group mean ages from year to year are not great enough to prevent the hypothesis from being tested with available data.

Within region between sex correlations generally support the hypothesis; height correlations tend to be higher and statistically significant among younger age groups and diminish steadily among older ones. Males and females from the rural townships parallel each other more closely than those in Taipei where tracking weakens noticeably after 1983 or 1984. Fluctuations in weight are also generally consistent with the hypothesis, though within Taipei more age groups show significant correlations which may reflect differences in diet. Finally, age group plots consistently indicate a decrease in mean height in the school year 1982. This dip is greatest at maximum increment age, declining progressively thereafter in both regions. Though regional data was unavailable, values reported for Taiwan as a whole since 1964 reveal similar, but shallower, depressions in 1975 and 1976 with decrements following the same age related pattern as described for the 1982 recession.

From hunting to farming: the impact on health status in Western Liguria (Italy). V. FORMICOLA and A. CANCI, Dept. of Ethology, Ecology and Evolution, University of Pisa, 56126 Pisa, Italy.

The biological effects of the shift from hunting to farming is a matter of intense debate, particularly with regards to relationships between subsistence practices and health status. This paper summarizes pathological changes marking this important socio-economic transition in a restricted region of Northern Italy, by comparing a group of late Upper Paleolithic hunter-gatherers with a sample of Neolithic farmers who lived in the same area a few millennia later.

Pathological conditions exhibited by the two samples include: dental diseases, trauma, arthropathies, infectious diseases, effects of general and episodic stress, and inherited disorders.

The Upper Paleolithic sample is characterized by excellent oral health and absence of infectious diseases. These data, and the slight degree and frequency of stress indicators, point to positive relationships with the environment and good alimentary status. Evidence of familial hypophosphatemic rickets in members of a small, probably closely related, group does not change this

pattern of overall good health, considering the inherited nature of the disease and its mild expression. Patterns of degenerative joint disease, affecting primarily the shoulder in the hunter-gatherers and the lower spine in the Neolithic group, may be related to differences in activity.

With the beginning of farming, the spread of tuberculosis and frequency of caries indicate that dairy cattle domestication and changes in diet had dramatic effects on health conditions. However, the initial steps in animal and plant domestication in this area do not appear to be associated with an increase in general and episodic stress. Clear detection of temporal trends, therefore, are found mostly in infectious and dental diseases.

A further decline in health status occurs later, during the Eneolithic period, with the establishment of intensive agriculture and husbandry, possibly as a consequence of increased population density with subsequent increased pressure on the environment.

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Stature estimations and personal identification from lengths of long bones of Finnish soldiers killed in the World War II in Russia. T.P. Formisto, Ankarstocksvägen 19, 168 64 Bromma, Sweden

In 1990, the Finnish and Russian governments established a program aimed at locating, identifying and reburying the remains of soldiers from the two countries who had died in Karelia, Russia, during the Second World War and who had been buried there temporarily. The present study deals with the skeletal remains from Kiestingi in Karelia.

The estimated stature, based on the length of long bones, is an important element in the personal identification of human remains. This paper discussed whether comparisons of the recorded stature, registered at the time of induction into military service, and the calculated stature based on long bone measurements can be used in personal identification. Since there are differences between various methods of calculating stature from long bone measurements, three different methods, those of Telkkä (1950), Trotter & Gleser (1952) and Sjøvold (1990), were tested. Sjøvold's equations were used since these are among the most recently developed, and because he claims that they may be used regardless of racial origin.

The results of the present study indicate that Telkkä's regression equations give the most reliable

stature estimation of Finnish soldiers, and may be used in the identification of the skeletal remains in this project.

Reconstruction of Subsistence Practices at Farming Hamlets in the Southeastern U.S. Using Microwear Analysis. B.K. FREDERICKSEN, Department of Anthropology and Sociology, University of Southern Mississippi, Hattiesburg, MS 39406-5074.

A dental sample from six sites in northeast Mississippi and northwest Alabama was examined for patterns of microwear to determine differences in these patterns in order to reconstruct subsistence practices. These sites date to the Late Woodland (A.D. 600-1000) and the early Mississippian (A.D. 1000-1200) periods at which times populations were becoming increasingly dependent on maize. The roles that the smaller hamlets and farmsteads had in this subsistence transition are unclear as to whether they continued reliance on wild resources, growing maize as part of a tribute system, or whether they adopted maize as their staple food.

A total of 46 mandibular and maxillary second molars were examined at 500-1500x magnification using an environmental scanning electron microscope. Occlusal surface features, including pitting and scratching, were scored using Microwear 3.0 (Ungar 1997). Populations from the transition period were compared for intertemporal differences in subsistence economy, differences between large centers and rural hamlets.

Results demonstrate that the farming hamlets underwent a less dramatic transition in the woodland southeast than previously thought, and that the presence of maize in the archaeological record could be the effect of their participation in a maize-tribute system. The results from the microwear analysis were also compared to other bio-archaeological indicators, which also suggest that these populations did not suffer the health consequences traditionally associated with adoption of agriculture.

A New genus and species of the diverse New Mexico lemurs. J.W. FROELICH, D.J. FROELICH, and A. SCHMIEDICKE, Department of Anthropology, University of New Mexico, Albuquerque, NM, 87131.

A complete lower left dentition was recently uncovered in the early Eocene San Jose fm. The remarkably spatulate (even shovel-shaped), vertically implanted, but small lower incisors are the first known for the *Pelycodus* clade. From the horizontal crown wear, the upper



central incisor apparently occluded only with the relatively small lower I1. While contemporary *Pelycodus* had already lost its lower P1, the new taxon retains a small, well-worn vestige; in many other respects, also, this new taxon retains primitive features that suggest an ancestral relationship to *Pelycodus*. In particular, the lower P4 has a very strong metaconid, while a morphocline leads to its virtual loss in *Pelycodus danielsae*. Both the trigone of a newly discovered M2 and the trigonids are inclined and laterally compressed.

Nevertheless, the new taxon also shares many derived features with *Pelycodus*, such as a closed shortening of the trigonid (with the paraconid and metaconid closely twinned), very broad, rounded cusps, crenulated, thick enamel, and a short, but broad expansion of the talonid basin. The proposed, new hypodigm now consists of four specimens, including three lower second molars.

With respect to all early *Cantius* species, the new taxon also has a primitively developed, short and simple M3 hypoconulid lobe. This combination of primitive and derived features suggests that this is the sister of all other *Pelycodus* species and the clade may represent a new adapid subfamily, independent of, and possibly not even closely related to the notharctines. A preliminary phylogram supports these relationships and argues for further review of all adapids. The diverse New Mexico middle Wasatchian lemurs now comprise at least four genera and six species in one penecontemporary fauna.

Pair-bonds in Lemurs, Monkeys, Gibbons and Humans? A preliminary evaluation of semantics and reality in pair-bond models. A. FUENTES, Dept of Anthropology, Central Washington University

The pair-bond has been assigned significant evolutionary importance in models of social organization in many primate and nonprimate taxa. Three main scenarios are put forward to explain the evolution of the pair-bond: the infant care model, the infanticide model and the provisioning model. In Lemurs and Humans the pair-bond has been proposed as the basal element for current social structure. However, researchers in primatology and evolutionary biology continue to use a number of ambiguous definitions for the pair-bond, and many authors use the term interchangeably with monogamy. If the pair-bond is to be used as an integral element in the modeling of the evolution of primate social organization it must be clearly defined and amenable to quantifiable analysis. If it has arisen via natural selection we must be able to describe its specific contribution to individual fitness and use a set of measurable parameters to identify and analyze the pair-bond. Such measures would facilitate

comparison across primate and non-primate taxa to establish the similarities and differences in pair-bonds.

Here I present a review of the current usage of the pair-bond concept and propose a set of measures for quantitative analysis of pair-bonds. These measures include duration of association, reproductive potential, copulation, spatial-temporal characteristics, biological relatedness, and specific behavior sets. Preliminary results from a comparison of these measures across the extant primate genera *Eulemur*, *Haplemur*, *Avahi*, *Varecia*, *Indri*, *Aotus*, *Callicebus*, *Hylobates*, and *Homo* are also presented. These results suggest that the pair-bond may not be similar across taxa and that a re-configuring of evolutionary models based on the pair-bond may be needed.

Modeling gestational age-specific infant and neonatal mortality T.B. GAGE, Department of Anthropology, University at Albany, State University of New York, Albany 12222.

Statistical examination of birth weight and gestational age distributions indicate that birth cohorts are composed of two or more sub-populations. One sub-population appears to account for the normal process of fetal development while the other represents fetuses disturbed in some way during development. Previous research has also shown that birth weight-specific mortality differs between the two sub-populations. This paper examines sub-population and gestational age-specific infant and neonatal mortality.

The model used in this research consists of a two component Gaussian mixture model with separate logistic regression terms on each component. The mixture model separates births into normal and disturbed births, while the logistic regression terms account for the gestational age-specific mortality of each sub-population. The data consist of 68,868 white male and 64,974 white female infants born in the state of New York in 1988. Standard maximum likelihood procedures are used to fit and compare models.

The results indicate that like the previous analysis of birth weight-specific mortality, gestational age-specific mortality differs significantly between the two sub-populations ( $p < 4 \times 10^{-10}$  and  $1 \times 10^{-12}$  for male and female infant mortality respectively). Further, infant mortality is higher in the disturbed sub-population as is the case with birth weight. In the case of gestational age, male infant mortality is 0.4/1000 in the normal and 44.0/1000 in the disturbed sub-populations. On the other hand, the pattern of sub-population and gestational age specific mortality differs considerably from the corresponding study of birth weight. Mortality in the disturbed sub-population declines monotonically with gestational age in both males and females. Mortality in the normal sub-population is constant with respect to gestational age in males, and increases slightly ( $p < .004$ ) in females. Thus evidence for a postterm increase in mortality is weak and confined to the normal sub-population. Most of the variation in mortality associated with variation in gestational age is due to the disturbed sub-population. The implications of these results are discussed.

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Health, Politics, and Population Movement in the Susquehanna Valley. C.M.GAGNON, University of North Carolina, Chapel Hill, NC, 27599-3120.

In AD 1608 Captain John Smith encountered a group of Native Americans at the mouth of the Susquehanna River on the head of the Chesapeake Bay, known to those he had previously contacted as the Susquehannocks. Throughout the 17th and 18th centuries the Susquehannocks were important players in the struggles among Native Americans and European Colonists for control of land and resources. Linguistic, ethnohistoric and archaeological evidence suggests that the Susquehannocks (along with other Iroquoian tribes of Mohawk, Oneida, Onondaga, Cayuga and Seneca) developed from the prehistoric Owasco Culture of New York and northern Pennsylvania. The Susquehannocks migrated south along the Susquehanna River from the North Branch to the Lower Valley circa AD 1550. The previous inhabitants of the Lower Valley, the Shenks Ferry, were not known historically having been eliminated/displaced/absorbed by the invading Susquehannocks.

The skeletal remains of 130 individuals from the North Branch and Lower Valleys were examined in this study. Included in the sample are individuals of the prehistoric Owasco Culture, protohistoric North Branch and Lower Valley Susquehannocks, and prehistoric and protohistoric Shenks Ferry. In order to assess health status, skeletal remains were examined for evidence of stress as indicated by the presence of anemic responses, periosteal reaction of bone, and enamel hypoplasias. In addition, all individuals were examined for periodontal disease, caries, abscesses and antemortem tooth loss in an effort to control for the influence of dietary change on health. Preliminary analysis indicates that individuals of the Shenks Ferry Culture were more stressed in both the prehistoric and protohistoric periods than were the Susquehannocks of either period or geographic location.

The Susquehannock migration to the Lower Valley can be explained as a result of the interaction of health status and politics. In the late prehistoric the "League of the Iroquois" developed as a political entity creating a powerful confederacy by bringing together five of the Iroquoian tribes. The Susquehannocks were not drawn into this alliance placing them at a great disadvantage. In response to this political pressure, the Susquehannocks attempted to remove themselves from the area of League influence, colonizing both the Lower Susquehanna and Potomac Valleys. In the Lower Valley they encountered the Shenks Ferry, and it was the relatively poorer health status of these people which allowed the Susquehannocks to be successful in their colonization of this area, creating a new homeland and setting the stage for historic encounters.

GROWTH of the Akwesasne Mohawk Nation youth. M.V. GALLO, Department of Epidemiology, University at Albany, New York; L.M. SCHELL, Department of Anthropology, University at Albany, New York; J. NEWMAN, Department of Education, University at Albany, New York; and THE AKWESASNE TASK FORCE on the ENVIRONMENT, First Environment Research Projects and Akwesasne Task Force on the Environment, Rooseveltown, New York.

The purpose of this study is to investigate the relationship of polychlorinated biphenyls (PCBs) and the physical growth of Akwesasne Mohawk youth. PCBs are a group of 209 related compounds released into the environment and suspected of being neurotoxic and endocrine disruptive. The Akwesasne Mohawk Nation is located at the intersection of

New York, Ontario, and Quebec with a population of approximately 10,000. As there is little data on Native American adolescent development, this report presents results from the analysis of preliminary growth data; PCB assessments are not included at this time.

The sample consists of 55 males and 74 females drawn from youth within the Akwesasne community between the ages of 10 and 16.9 years (mean n per age group = 18). Anthropometric measurements (height, weight, seven skinfolds; four circumferences; three skeletal breadths) were made between 1996 and 1998 by trained research staff following published anthropometric protocols. There are no growth standards developed from a national probability sample of Native American youth. Therefore, comparison to several reference samples are necessary.

Heights of Mohawk youth are similar to values for both non-Native and Native American youth in NHANES III. Mohawk youth weigh significantly more than non-Native youth (NHANES II). In comparison to NHANES III values for Native Americans, Mohawk females are significantly lighter at ages 12 and 16, and Mohawk males are similar at all ages. Mohawk males and females exhibit greater skinfold thicknesses when compared to the 50<sup>th</sup> percentile (NHANES II) of their age. The relationship of Mohawk youths' height and weight to the US reference values does not change with age.

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Primate brain "language" area evolution: Anatomy of Heschl's gyrus and planum temporale in hominids, hylobatids and macaques and of planum parietale in *Pan troglodytes*. P.J. GANNON and N.M. KHECK, Dept Otolaryngology, Mt Sinai School Med, NY, NY 10029.

A human-like pattern of Heschl's gyrus (Hg) and a left hemisphere predominant asymmetry (L>Ra) of the *planum temporale* (PT) "language" area in chimpanzees was recently reported (Gannon et al., *Science*, 1998). In humans, a right hemisphere predominant asymmetry (R>La) of the *planum parietale* (PP), also involved with language-related tasks, has been reported to be independent of PT L>Ra. This study was designed to determine the: 1) broader anatomic expression of Hg and PT in hominoids and macaques, and 2) relationship between PT L>Ra and PP R>La (if expressed), in chimpanzees.

For Hg/PT measures, cadaver brains used were: *Gorilla gorilla* (n=6); *Pongo pygmaeus* (n=9); *Hylobates lar*, (n=6); *Symphalangus syndactylus*, (n=6); and *Macaca fascicularis* (n=10). The sylvian fissure (SF) was spread open widely and a lateral linear measure of PT made with calipers. For PP measures, cadaver brains of *Pan troglodytes* (n=23) were used. PP contours were traced with braided silk along the adjacent ascending limb of SF, then straightened silk cord length was determined with calipers.

Results showed that similar to that reported for humans and chimpanzees, Hg and PT were expressed robustly and bilaterally in both gorillas and orangutans. Further, PT showed L>Ra in 5 orangutan and 5 gorilla and R>La in 2 and 1 brains respectively. In 2 orangutans, PT R=L. In hylobatids, the Hg/PT complex was not evident in siamangs but was prominent in 5 gibbons. In no case did macaques show evidence of Hg or PT. In chimpanzees,

similar to humans, PP was significantly larger on the right hemisphere ( $p=0.03$ ). Further, also as in humans there was no significant co-occurrence of PT L>Ra with PP R>La.

The human-like pattern of PT L>Ra may have been expressed at least as early as our common ancestor with orangutans. Further, independent expression of PT and PP asymmetry appears to serve as markers of hemispheric laterality, at least in our common ancestor with chimpanzees. Whether these classic asymmetric human brain "language" regions are also used for communication-related tasks in great apes is currently being investigated.

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A preliminary study of mantled howling monkey (*Alouatta palliata*) ecology and conservation on Isla de Ometepe, Nicaragua. P.A. GARBER, J.D. PRUETZ, A. LAVALLEE, and S. LAVALLEE, Department of Anthropology, University of Illinois, Urbana, IL 61801.

In this paper we examine the ecology and conservation status of mantled howling monkeys (*Alouatta palliata*) on Isla de Ometepe, Nicaragua. Ometepe is a volcanic island located within the southeastern edge of Lake Nicaragua. It is the largest island in the world situated in a fresh water lake. The area is characterized by zones of dry deciduous forest, cloud forest, forest-shaded coffee plantations, agricultural fields, and areas cleared for human use. Ometepe has been separated from the mainland for several thousands of years, and little is known concerning the degree to which howling monkey populations on Ometepe differ genetically, behaviorally, or ecologically from howling monkey populations in other regions of the neotropics.

From December 1997 through January 1998, we conducted a preliminary field study of a group of approximately 20 mantled howling monkeys inhabiting a 4 ha area that is part of the Ometepe Biological Field Station. The study group contained at least 5 adult males and was frequently observed to fission into smaller subgroups during the day. Mean subgroup size was 7.9 individuals ( $\pm 2.8$ ). In addition, 85 trees fed in by the howlers were marked, identified, and the location of each tree was mapped. During this dry season study, the howlers consumed leaves from 53% of these trees, flowers from 32%, and fruits from 14%. On average, each howler subgroup fed in 3.0 trees per observation hour. In order to identify the structural characteristics of the forest, we divided the study group's home range into 67 25x25m quadrats. Each quadrat was plotted on the field map and measurements of tree height, density, and degree of human disturbance were compiled. These results indicate that 41% of all quadrats were characterized by significant levels of human disturbance such as logging, trails, and cultivated areas. We also interviewed members of the local community to identify which trees were most frequently harvested from the forest. Several trees important in the howling monkey diet, such as *Gliricidia sepium* and *Calycophyllum candidissimum*, were among the most common tree species cut for firewood. Additional relationships between howling monkey ranging patterns, tree species distributions, and forest disturbance are discussed. A long range conservation plan integrating local, national, and international efforts to preserve Ometepe's remaining forests and howling monkey populations is presented. Support to conduct this research was provided by the Ometepe Biological Field Station, Nicaragua.

A Java program for the calculation of minimum number of individuals from commingled and fragmented skeletal samples. G. GEBHARDT<sup>1</sup>, L. TENNEYCK<sup>2</sup> and E.A. REGA<sup>3</sup>, Computer Science, Harvey Mudd College (1) and W.M. Keck Science Center (2,3), The Claremont Colleges, Claremont, CA 91711

Calculating the minimum number of individuals (MNI) from a sample of commingled skeletal remains can be an arduous and time-consuming task, particularly when the NISP (number of specimens) is large, the sample is highly fragmented or rapid field collection of data is necessary due to legislation. A computer program to refine the generation of MNI from a sample was created to simplify the process, increase the accuracy and precision of the result, and decrease the possibility for error. The program is written in Java 1.1 to achieve maximum portability while maintaining a robust user interface, utilizing as its main interface a customized descendent of the JTable component of Sun Microsystems's Swing library. The system involves a user-specified coding of skeletal elements and elemental fragments, as well as age, side and sex values, where possible to ascertain. Data are then entered into a spreadsheet and exported as 4-column separated value (.csv) files. This program then creates virtual skeletons which possess specific age and sex characteristics. Bones are placed into the skeletons with regards to size, provenience and side in order to find the minimum number of skeletons/individuals in a given sample. Results from the analysis of Jamaican precontact and Early Medieval English human skeletal samples are presented to illustrate the workings of the program. The beta version is available at <http://www.cs.hmc.edu/~glenn/descriptions/MNI.tar>.

Nasal valve function and location as determined by *in vitro* fluid flow studies. J.N. GEORGI, S.E. CHURCHILL, L.L. SHACKELFORD and M.T. BLACK, Duke University, Durham, NC 27708.

Despite considerable attention by respiratory physiologists, the exact location and specific function of the human nasal valve remains unclear. Previous studies have variously placed the nasal valve at the *limen nasi* in the external vestibule, at the position of the skeletal piriform aperture, at the anterior margin of the inferior conchae, or along a zone extending from the limen to the turbinates. It is also clear that the nasal valve exacts a considerable physiological cost on breathing by greatly increasing airflow resistance and by functioning as a flow-limiting segment (Starling resistor) during forceful inspiration. The function of the nasal valve is currently unclear, but it has been suggested that it behaves as a Venturi throat or "nozzle" that produces turbulent flow

regimes and facilitates conditioning of inspired air by contact with the nasal mucosa.

Anatomically accurate models of the upper respiratory tract of 10 European-American cadavers were employed in a fluid flow study to address these questions. Models were obtained by direct casting of the unilateral nasal airways of the cadavers and were subjected to water and dye flow, with adjustment of water flow rates to maintain dynamic similarity with air flowing across a range of physiological rates. As dye and water flowed from the nares to the nasopharynx, the location at which laminar streamlines became turbulent was recorded as an indication of the position of the nasal valve. Measures of the cross-sectional area of the nasal passageway at the *limen nasi* and the internal chamber were used to estimate the relative constriction of the nozzle.

Results showed flow regimes to be highly variable among individuals, but revealed a clear tendency for the initiation of turbulence in the nasal vestibule anterior of the piriform aperture. Results are thus most concordant with previous claims that the region of the *limen nasi* is the functional location of the nasal valve. However, we also found a moderate (but non-significant) trend for increasing turbulence with increasing relative size of the valve, opposite the expectation of the valve functioning as a Venturi throat.

Size in *Eulemur fulvus rufus* from western Madagascar: Sexual dimorphism and ecogeographic variation. J. S. GERSON, Department of Biological Anthropology and Anatomy, Duke University, Durham, NC 27708.

In many anthropoid species, males are larger than females while most Malagasy prosimians do not show this sexual dimorphism in body size. Ecogeographic variation in size within a species or among closely related species also interests researchers. Here, I present morphometric data from a western population of wild red-fronted brown lemurs, *Eulemur fulvus rufus* for the first evaluation of body size dimorphism in western *E. f. rufus*. By comparison with an eastern population of *E. f. rufus*, ecogeographic variation in body size in living populations of lemurs is considered.

Adult individuals (n=22) were captured from the population at Anjamena, Madagascar; body weight and length, tail and limb lengths, and maxillary canine height (crown to gum-enamel junction) were measured. Results show no significant sexual dimorphism in body mass (males:  $\bar{x}=1.79$  kg, s.d.=.14; females:  $\bar{x}=1.84$ , s.d.=.10;  $Z=.78$ ,  $P=.43$ ). There is significant sexual dimorphism in canine height (males:  $\bar{x}=9.0$  mm, s.d.=1.0; females:  $\bar{x}=7.5$ , s.d.=1.0;  $Z=-2.72$ ,  $P=.007$ ). This western population ( $\bar{x}=1.80$  kg) is significantly lighter in body mass than an eastern population ( $\bar{x}=2.21$ ;  $Z=-5.65$ ,  $P=.0001$ ); limb proportions as measured by intermembral index are not significantly different.

The lack of body size dimorphism in this population is consistent with findings in other Malagasy prosimians including an eastern population of *E. f. rufus*. Sexual dimorphism in canine height in Malagasy prosimians is rare,

though similar trends in two other lemur populations suggest it may be more common than previously thought.

Comparisons between this western population and an eastern population of *E. f. rufus* confirm, with living populations of lemurs, findings of ecogeographic variation in subfossil lemurs and museum specimens of extant lemur species: western populations are smaller than eastern populations.

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Relative brain size is not independent of body size in primates: comparison between humans and capuchin monkeys. E. GILLISSEN, University of the Witwatersrand, Parktown, South Africa.

The most dramatic change that has occurred in hominid evolution during the last 3 million years is the increase of brain size. A disproportionate enlargement of the brain size relative to body size is characteristic of humankind. Relative brain size can be expressed by the residual values of individual species relative to a best-fit line between brain size and body size values. Among primates, the highest residual values are found in humans and in capuchin monkeys (*Cebus* sp.). When compared to the average of placental mammals, humans show a relative brain size about 6 times larger than expected and capuchin monkeys have brains about 3.5 times larger than expected. In comparison, chimpanzees have brains only about 2.5 times larger than expected. Capuchin monkeys therefore provide an interesting source of comparison when seeking an explanation for the increase in relative brain size in hominid evolution. The question remains: why is the human relative brain size value (or encephalization level) not paralleled among primates? Recent studies have stressed the energetic constraints on brain enlargement but a more basic constraint seems to be the body size itself. Sacher (1975) noticed that a brain weight vs. body weight ratio of 4 percent represents the upper limit for adult brain weight vs. body weight ratios in all orders of mammals. The actual value of this ratio is 2.0-2.2 percent in adult humans and 2.2 percent in *Cebus albifrons*. The expected values of this ratio are respectively 0.7 in adult humans and 1.6 percent in *Cebus albifrons*. If *Cebus albifrons* would have the same level of encephalization as adult humans, the brain weight vs. body weight ratio would be 4.3-4.5 percent in this species and thus would be above the upper limit for adult mammals. A body weight of around 10 kg is necessary to reach a degree of encephalization comparable to that observed in modern adult humans. It is therefore to some extent misleading to say that after modern humans, the next largest relative brain sizes among primates are found in capuchin monkey species (average adult body weight: 2.5-3.0 kg). Body size appears to be a constraint on relative brain size and residual values of individual species relative to a best-fit line between brain size and body size values are not independent of body size itself. This result is important when considering the encephalization level of miniaturized primates as callitrichids. This work was supported by the von Humboldt and the Fyssen Foundations.